THE SOCIETY

FOR THE

PREVENTION OF BLINDNESS.

AND THE

Improvement of the Physique of the Blind.

ON SPECTACLES:

Their History and Uses.

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Those interested in the welfare of blind children or adults wishing for further information, or to contribute to the objects of the Society, are requested to communicate with Dr. Roth, pro. tem. Hon. Treasurer and Secretary, at 48, *Wimpole Street, London, W.*

ON SPECTACLES.

I.—IN PAST TIMES.

THE origin of glasses for assisting defective sight is not known with anything like certainty. That the ancients were acquainted with convex lenses is undoubted. Layard found in Nineveh a plano-convex lens of rock crystal, one and a-half inch in diameter with a focus of four and a-half inches. In a grave at Nola, a city of Magna Græcia, a plano-convex glass lens mounted in a gold frame was found, and Seneca speaks of a magnifying glass, made of a glass globe filled with water, which was used for deciphering small and indistinct writing. Concave glasses for correcting short-sightedness do not seem to have been known to the ancients. Some authors indeed have alleged that Nero was short-sighted, and used a concave lens made of an emerald, for the purpose of seeing the combats of the gladiators. But it is just as probable that Nero's eyes were only weak, and that the emerald was a plain cut jewel which he used because the colour was grateful to his eyes, just as persons afflicted with irritable eyes find comfort in wearing green glasses.

Probably the Chinese used convex spectacles long before they were known to western civilisation. In Europe, 1290 is generally believed to be the date of the invention of convex spectacles for old people, and Salvino d'Armato,

who died in 1317, is credited by many with being their inventor. The Dominican, Alexander da Spina, of Pisa, is a rival claimant of the invention. But spectacles do not seem to have come into anything like general use until the latter part of the fifteenth century. It is common enough to see spectacles figuring in pictures painted after this period. There is a picture of the adoration of the Magi, of the date of 1466, in which one of the three wise men is looking at the infant through a binocular glass. Luther frequently speaks of spectacles in his writings. The invention of printing gave a great stimulus to the demand for spectacles. Before the sixteenth century, pictures only represent spectacles as being worn by old men for reading or looking at near objects. Consequently these spectacles must have been fitted with convex glasses. But in a picture by Raphael dated 1517, Pope Leo X., who was extremely short-sighted, holds in his hand a concave glass. So that we may safely say that spectacles for the short-sighted were manufactured in the sixteenth century. Maurolycus, of Messina, who lived from 1494 to 1575, describes the two kinds of glasses. He says that concave glasses disperse the rays of light, while convex ones collect them; that the former are useful for the short-sighted, the latter for the old-sighted. He also says that the spectacle makers mark their spectacles with the age for which they are suitable.

The difficulty of manufacturing spectacles in past centuries made them very expensive, and their use was necessarily confined to the comparatively rich. But as there is no reason to suppose that old persons did not become presbyopic, and that myopia was uncommon among young people, an immense amount of discomfort must have been endured by both old and young before the invention of spectacles, and as long as they could only be bought at a

high price. Now-a-days the processes of the manufacture of spectacles have been so greatly improved that they can be sold at a price that the poorest can afford, and this cheapness of these necessaries has added incalculably to the sum of human happiness, and is a powerful adjuvant to the passion for education and particularly for reading, assisted by cheap literature, and writing, encouraged by cheap postage, which distinguishes the present age.

II.—IN OUR OWN TIMES.

In order to give an insight into the present state of our knowledge of spectacles and their employment it will be useful to go back some years and see what were the views of ophthalmologists on the subject, say, in 1840. We look into a big two-volume work on ophthalmology that was published about that time. In 1,000 pages we find only ten devoted to myopia, presbyopia and spectacles. And now-a-days the least diffuse of authors would hardly think that he could give a satisfactory treatise on this branch of knowledge in less than a good sized volume. What is the reason of this difference? Is it because medicine has adopted a more technical method, that oculists have not refrained from devoting their attention to a knowledge of physical aids? Is it perhaps, because owing to the influence of an alteration in the mode of living of the people, the number of imperfections of the eyes and the need for remedies for these have suddenly multiplied? Is it because spectacles can now be manufactured much more cheaply? These things may have had something to do with it, but the chief cause of the immense development of our knowledge of the imperfections of the eye which can be corrected by spectacles, and which have long existed, not one of the least of the acquiremements of recent times, is

owing to Helmholz's discovery of the ophthalmoscope in 1851, and to the insight it has given us into the relation of diseases of the eye to the varieties of its form. Thereby not only has the doctrine of myopia been completely revolutionized, but an impulse has been given to a real scientific investigation of a subject that had hitherto been left in the hands of empirics, many of whom were undoubtedly persons of great experience and skilfulness, but they were deficient, as such persons must always be, in prevision and knowledge of the unusual.

The comprehension of the differences in the visual range of the eye or the varieties of the optical parts of the eye, was immensely increased by the labours of F. C. Donders, of Utrecht, who, since 1855, devoted his vast physiological knowledge to ophthalmology, and replaced the previous blind groping by exact science in a manner hitherto unattempted. Though some others had simultaneously made investigations in this sphere, yet their imperfect and confused views were completely eclipsed by Donders' book,* which treated the whole subject with wonderful lucidity and masterly completeness. We must borrow from this book when we wish to treat of the employment of spectacles, and endeavour to give a clear idea of the classification of those various kinds of vision which go by the names of presbyopia, myopia, &c. This we can do by the aid of a few figures, without any previous knowledge of mathematics and physics, which cannot be expected of the general reader.

If we examine a large number of persons of the same

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* *The Anomalies of Accommodation and Refraction of the Eye*, New Sydenham Society, London, 1864. Any one who wishes to study the latest account of the subject should read E. Landolt's *Refraction and Accommodation of the Eye*, an English translation of which has recently appeared.

age—say twenty years—with regard to their range of vision, by setting them to tell an object of a certain size at a certain distance, we shall find that they are first of all divided into two sets: the one set can recognise, for example, a letter one centimeter in height and two millimeters in breadth at a distance of six meters; the other set are unable to do this. The first set we may consider as possessing *normal vision.* Are the others *short-sighted?* Some of them undoubtedly are. But some of the second set are, perhaps, *weak-sighted,* it may be because their eyes are deficient in transparency, or because their optic nerves are not in full strength. Others again are not short-sighted in the sense of being able to see better through the ordinary spectacles of the short-sighted; on the contrary, they see well with the convex glasses of old people, and yet they must hold small print close to their eyes, and they cannot see well at a great distance; they are *over-sighted* (hypermetropic). Finally there are others who do not see well either near or distant objects, the glasses of the short-sighted do not help them, neither do the glasses of old age, and yet the most careful inspection reveals no dimness or disease. Their eyes are irregular in their curvature *(astigmatic).* The weak-sighted whom no glasses enable to see in a normal manner must be handed over to the physician; their defect may be due to very various causes which it is impossible to explain to those who do not possess special knowledge. But we may now consider the other cases more in detail. We may select three distinct cases for investigation: one who can see the letter above-mentioned quite well at a distance of six meters without artificial assistance; a second who can only see it distinctly with concave glasses; and a third who sees with convex glasses as well as the first; and if we were able to make an accurate measurement of the eyeballs of such persons, we

should find that these three cases differ in regard to the *length of their eyes.* Suppose the length of the axis from the front to the back of the eye is in the normal-sighted twenty-two millimeters, it will be found that in the short-sighted it is twenty-six millimeters, and in the over-sighted twenty millimeters. On these facts are founded the modern classification of eyes in respect of their range of vision, or of their capabilities as optical instruments or lenses, the nervous power of all being the same.

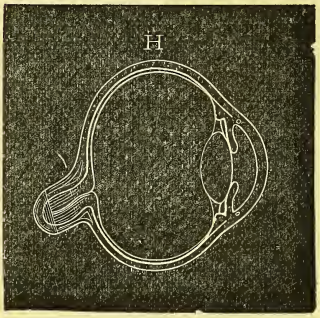

Fig. 1.

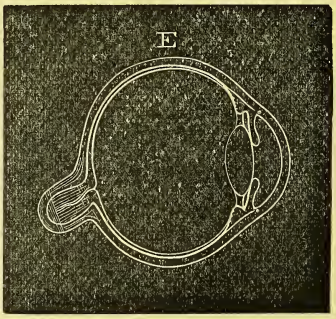

Fig. 2.

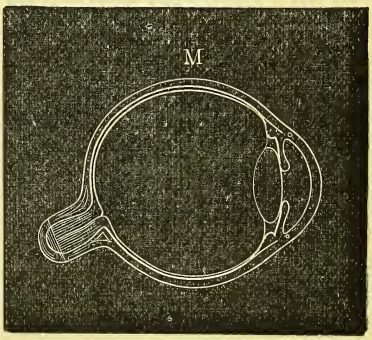

Fig. 3.

An examination of the above three sections of the eye (figs. 1, 2, and 3) shows how they vary in length. The shortest, marked H (hypermetropia), resembles a ball compressed from before backwards; the second, E (emmetropia), is longer and more spherical; the third, M (myopia), is an

elongated oval and exactly the contrary of H. But not in every respect! For if we lay the three sections one on the top of the other (fig. 4) we observe that they are exactly

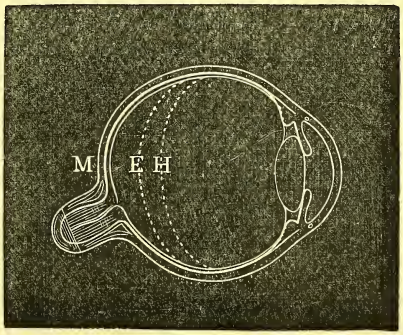

Fig. 4.

alike in their anterior outline, and cover one another perfectly, and they only differ in their respective lengths. Let us take three ordinary burning glasses, leave the front surface of all three alike, grind the back surface of one flatter, leave the surface of another unaltered, and make the back surface of the third rounder and the whole glass thicker by cementing on to it a second more convex glass, we shall then obtain a copy of these three forms of the eye, and, at the same time, understand that if we could make H as long as E, and M as short as E, we should thereby be enabled to make them all of the same refractive power—that is to say, lenses of like thickness. And this we are able to do—very nearly!

The great advance made in recent times is owing to the knowledge that the different seeing distances depend on the differences in the length of the eyes, and on the sharp division betwixt defective vision from different refractive power of the lenses of the eye, and faulty *conformation* of the eye. Did this knowledge spring at once in perfection from the head of a Jupiter? Not so, for there were premonitions. But these were mere suggestions and guesses

unsupported by proofs and not duly followed up, or stated in such an unintelligible manner that they could only be properly understood after Donders had given us the key which we shall now proceed to make use of.

In the above figures No. 2 represents the eye which approaches nearest to a circle in shape and it is indicated by the letter E. It is usual to do so, or it might be marked N (normal), were it not that that term includes all the properties of the eye. E (emmetropia) implies only the *normal dimension* that is capable of uniting in a distinct picture on the retina the parallel rays proceeding from objects at an infinite distance. Different from this are the two other eyes, one of which is so short that the parallel rays from infinitely distant objects are only focussed behind the retina (hypermetropia, long-sight), the other is so long and cylindrical that such rays come to a focus in front of the retina (myopia, short-sight). The degree of the divergence of the form of these two eyes from that of the E eye, is equal to the degree of the correcting spectacles; in the case of H, these must have an increasing, in that of M a diminishing, effect—in other words the former must be convex, the latter concave. The matter may be stated aphoristically thus: the degree of long-sightedness is equal to a convex glass which raises the eye in question to the power of a normal (emmetropic) eye, and the degree of short-sightedness is equal to a concave (dispersing) glass, which reduces the excessive length of the myopic eye to the condition of the normal eye. Evidently the question now is to find out a way which will enable us to determine the exact amount of the too-much and the too-little. For very many cases it will suffice to ascertain what glasses will restore the well-known average sight for distant objects, in order to find how much it differs from the normal; but in many cases this is not

sufficient, the box of graduated spectacles and the sight test are not enough, the ophthalmoscope alone can give us the desired information and enable us to determine the exact measurement with almost mathematical precision.

We have been considering the conditions of the eyes dependent on the length of their axes, or, we may say, on the thickness of the lens made by the transparent parts of the eye (cornea, crystalline, aqueous humour and vitreous body)—in other words, on the refractive power of the dioptric parts of the eye in a state of repose. But where there is life, there also is motion, and a living eye does not remain a mere motionless lens. A peculiar mechanism allows it to range from the finest point to the tops of the distant hills without any diminution of distinctness of vision, provided the eye was originally "emmetropic as regards its measurement." This faculty of accommodation is common to all eyes (E, H, and M) as long as they are not too old, and is produced by an advance and increase of thickness of the crystalline lens of the eye, the effect of which is precisely the same as when, by means of a screw, we alter the position of the glasses in a telescope, according as we wish to observe a near church steeple or a distant star. Take some watch glasses, two of modern flat watches and two of old-fashioned thick watches, connect each pair together in such a way that we may be able to fill the interval between them with water; we have thus two lenses, which, though made of identical materials, are of different shapes and have different properties. The flat glasses represent the crystalline lens of the eye which is looking at *distant* objects; the more globular glasses that of the eye which is looking at a small object very close to it. Every eye, be it normal-, short-, or long-sighted, can make use of this telescopic screw in its interior but, of course, only within the domain marked out for it by

its form, and as long as the screw continues to perform its office. But it ceases to do this, not because it is actually worn out, but in consequence of the greater resistance opposed to it by the parts of the eye itself (especially its crystalline lens) having grown harder, tougher and more immovable. Indeed this diminution of the accommodating faculty, this hindrance to the action of the screw, is so universal and so regular that it may serve as an index for determining a person's age. It is owing to this that the most excellent eye which was accustomed to see with equal facility and distinctness the most distant and the nearest objects, after passing the fortieth year finds the reading of ill-printed newspapers difficult, at first in the evening, then on dull days, then on any kind of day; that later it can only read with difficulty or not at all the very best print—that it becomes long-sighted, or we should rather say *old-sighted, presbyopic.* Donders made a most significant observation when he referred the occurrence of old-sightedness, a process common to all kinds of eyes, to the changes which, like grey hair, wrinkled skin, &c., are inevitable, and asserted that they were owing to a drying up of the crystalline lens, which is itself a cutaneous tissue.

Knowing this, it is clear that in order to correct the defects of vision in adult and advanced life we must supplement the diminished refractive power of the desiccated crystalline lens by means of a convex glass, and that we can decide beforehand what power of spectacles should be worn by persons of a certain age in order to enable them to read small print, &c.

The correction of the defects of old sight was the first kind of spectacle-knowledge that was cultivated, and the reason of this is simply because presbyopia is the inevitable consequence of advancing life. All the spectacles known

to us up to the end of the fifteenth century were furnished with convex glasses; the pictures up to that period represent only *old* people using spectacles for reading with; indeed, the *first way of numbering spectacles was according to the age for which they were suitable!* Much later followed the numbering of spectacles according to the semi-diameter of the spherical mould in which the glass was polished, and still more recent was their denomination according to the metrical measurement of their refractive power. Given the age of the individual, provided his sight was originally normal, the degree of his old-sight (improperly termed long-sight, for the normal eye also sees distant objects quite well) is easily determined; indeed, the spectacles required often give curious information with respect to the difference between the actual age and the age confessed by the patient. It is different with the hypermetrope, who requires convex glasses at an earlier age; we must ascertain the quality of the glass with which he sees distant objects well, and add to this the convex glass for reading corresponding to his age. The short-sighted also becomes old-sighted; but it is only obvious in him when his myopia is slight and inconsiderable, such as does not require him to bring small objects closer to his eye than the normal working distance. Because the extremely short-sighted needs no convex glass for reading, even when his head has long been crowned with grey hairs, short-sighted eyes are often held to be good eyes. But the number of *very* short-sighted persons who acquire in their old age a better sight for distant objects is very small, and it is only in the case of *slightly* short-sighted people that a partial cure is effected in advanced life. In the case of a short-sighted person who, in spite of good visual power for near objects, can no longer read with facility or thread a needle, we must deduct from the convex glass corresponding to

his age the degree of the concave glass that corrects his myopia for distant vision.

The selection of spectacles for presbyopia is quite simple. We may lay down this general rule: *that the weakest convex glass with which the smallest print can be read is suitable for working spectacles;* but there are exceptions to this rule, as glasses adapted for particular distances are required for piano-playing, painting, &c. For painters the so-called Franklin spectacles, in which a distant glass is introduced into the upper half of the spectacle frame, and a near glass into the lower half, or the spectacles with a double focus where different degrees are ground upon one glass, are very useful. If small print cannot be read with any glasses, there must be *disease* present.

Should spectacles be resorted to at the first signs of difficulty in working or reading in the above described circumstances? Certainly, when there are special calls on the eyes for continuous fine work, especially at night, but not for all coarse work, otherwise one becomes too much the slave of spectacles. But it should be particularly insisted on that waiting too long before resorting to spectacles, and employing the bad assistance of too strong a light, are more injurious and only necessitate a rapid increase of strength of the spectacles. As a rule we find that *too weak* glasses cause more inconvenience to the old-sighted than *too strong* glasses.

The second principal category of eyes, those short compressed eyes which are termed far-sighted (hypermetropic) H), are remarkable for their smallness. In extreme cases this is obvious to the most cursory inspection, as much by the flat shape of the forehead and cheek, as by the smallness of the eye, which, when the look is directed to one side, the lids being widely opened, permits the highly curved equator of the eyeball and even its posterior aspect,

its back pole, to be seen. Geographical expressions are quite appropriate here, as the form of the eyeball resembles that of the terrestrial globe. This kind of eye was, with the exception of a few celebrated cases, until quite recent times, unknown, not understood, indeed falsely denominated *weak sighted*, and it is one of Donders' great merits to have elucidated this group in a very complete manner. And yet such cases are so common! Not only do 88 per cent. of all those suffering from internal squint belong to it, not only do the numerous work-people who, at 20 to 30 years of age, complain of speedy and painful fatigue of the eyes when engaged in fine and continuous work suffer from it, but likewise a large number of persons who are commonly regarded as short-sighted because they bring objects close to their eyes, but who are not really myopic because they are not helped by the *concave* glasses of the short-sighted, but by the *convex* glasses of the aged. The amount of misery that can be relieved by a knowledge of this condition and its correction by convex spectacles is incalculable.

The small eye of the hypermetropic must always turn the accommodation-screw to its utmost extent in order to see near objects distinctly, and when this, owing to increasing age, begins to lose its power, the exertion becomes fatiguing, indeed painful and insufficient. In that case relief is to be obtained, and the ill-developed eye made to see like the normal organ, by means of the convex glass.

Even among children, many of whom are hypermetropic, the number of those who cannot correct permanently the smallness of their eyes by exertion of the accommodating power is considerable. It is a great gain in a physical and moral point of view that in the town schools of Zurich we have been enabled by the introduction of a regular inspection of the eyes to treat with requisite leniency those

children who had been previously ignorantly badgered and scolded when reading, writing, or sewing. They no longer suffer, in consequence of the exertion they are required to make, from headaches, which may be productive of permanent mischief, and the punishments that used to be so frequently imposed on them torture them no more with the sting of unmerited contempt. How should we deal with hypermetropes as regards spectacles? They require convex spectacles when they *cannot see well for a continuance*, still more when they *cannot see well at any time*. They need the *strongest* convex glass that enables them to see distant objects as well as those whose eyes are normal, the former only for working on near objects, the latter also for distant vision, *e.g.*, for looking at what is written on the black board, at maps, &c. Young persons do well to dispense with spectacles when there is no need for very accurate seeing, as when taking a walk, playing, &c.; otherwise they soon come to see without spectacles worse than before. But there are two exceptions to this rule: when the work causes pain, and when a squint is present, spectacles should always be worn. In later years when with advancing life the accommodation-screw loses its power, the ever-increasing power of the convex glass is the protection against inability to work. *Here, as in the case of presbyopia, the most frequent fault is too weak spectacles.* There is, no doubt, and often associated with the defective development of the eye, which is undeniable in extreme cases of hypermetropia, only too often a real weakness of the visual power, which is irremediable by any glass, even the most complicated forms.

There is another kind of over-sightedness which may be briefly noticed, that which is caused by *the operation for cataract*. When the opaque crystalline lens—*the cataract*—is extracted, the eye, still retaining its normal length, loses

one of its important component parts. It is as though in the photographic camera, while its length remains the same, the distance of the sensitive plate from the object to be depicted is not altered, but the lens that forms the picture is exchanged for a much weaker one. Will it surprise any one that the picture is not thrown on the plate, is in fact destroyed? Certainly not! But most of those operated on for cataract, however successful the operation may have have been, are disappointed that they can only see well with spectacles, and that they require different kinds for distant and for near vision. But that it is impossible this can be otherwise will be obvious when they know that the cataract is nothing but the chief lens of the eye, and that the operated eye *must* have thereby become highly hypermetropic, because a lens has been removed from the interior of the eye, just as in the naturally hypermetropic eye a portion of the lens is wanting in its posterior pole. But what can we think of the following passage in a much read periodical:* "The lens of the eye, lost for ever in the operation for cataract, is replaced by so-called cataract spectacles, by whose convex lens the rays of light are conveyed into the eye and the visual power is poorly (?) restored by various kinds of spectacles. *Without these spectacles darkness and everlasting night is spread before the eye.*" Absurd pathos! which is just as far from the truth as the amazing descriptions of he sudden seeing of persons born blind the moment the bandage is taken off. Such persons, after the most successful operation, still continue to rely on their well-proved sense of touch for a long time, until the faculty of recognising objects and judging distances, which they slowly

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* MAX KRETZER, *Die Blinden*, p. 301, *Nord und Süd*, September, 1884.

acquire, enables them to give the preference to the new sense of sight.

During the last thirty years short-sightedness has engaged the attention of physicians, teachers and hygienists, to a remarkable extent, and it has become the subject of much discussion in regard to its origin and prevention. We shall not enter on this vast theme, but confine ourselves to our subject, which is: spectacles and their employment. A few points bearing on this must first be considered.

In our presentation of the different forms of the eyes, we have seen that the myopic eyeball is longer than the normal; this elongation may amount to more than a centimeter, and that the increase of length corresponds to the degree of myopia is a further proof of the correctness of the conclusion. From the length of the eyeball we can calculate the degree of myopia, and from the degree of myopia we may calculate the length of the living eyeball. Now the question arises: Do we find this elongation of the eye in new-born infants? All the most recent investigations show that short-sightedness is hardly ever found in new-born infants*, further that it is very rare before six years of age, after that age the number of short-sighted eyes rapidly increases, and after twenty years of age no new individuals are attacked, but only those already affected by it tend to become short-sighted. Congenital myopia, implying an elongated form of the eyeball, is therefore exceedingly rare and must be regarded as a *malformation;* myopia is almost always *acquired;* but those who have a hereditary predisposition are to be distinguished from those who become myopic *without such predisposition.* The proportion of the

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* Schleich invariably found hypermetropia n more than 100 infants. *Tübinger Mittheil.* II., 1, 84.

two is not yet known to us, and is variously estimated. Certain it is that the hereditary predisposition may, but not must, act exceptionally, and is on that account more dangerous, because the hereditarily short-sighted more rapidly reach a higher and dangerous degree; indeed it would appear that this increase of degree persists through several generations. Those who have a hereditary predisposition to myopia require more prophylactic treatment than those who are not so predisposed. Here we encounter a condition of general importance, which is often enough erroneously apprehended. Let us take a very ordinary instance. How often does it happen that when we are endeavouring to impress on a mother the necessity for better care of her child's teeth, she will meet us with the remark: "What's the use? I have had bad teeth myself!" Similarly the hereditary character of myopia is often alleged as an excuse for the neglect of precautionary measures. In both instances the very opposite is right. When there is an unfavourable predisposition, thrice as much care and attention is required to save the teeth, the eyes, the lungs; they may, however, be saved thereby! The danger and severity of a disease do not always depend only on the quantity of the morbific causes, but on the individual power of resistance; if the latter is weak, our first object should be to strengthen it, and, to keep to one example, the expenditure for tooth-brushes and tooth-powder in the household bills must be increased. Acquired myopia is as well ascertained a fact as hereditary myopia, and we have undoubted evidence from careful observation that hypermetropic eyes may become myopic. The sum total of myopes at twenty years of age is the number of those who are hereditarily predisposed, and of those who, without predisposition, have become short-sighted from having been formerly hypermetropic or emmetropic.

Is this transition to myopia dangerous? Short-sightedness is often spoken of as though it were an appropriate adaptation to the kind of work, just as the epidermis of the violin-player's fingers becomes thickened. If with the notion of adaptation we combine that of appropriateness, this is quite wrong with respect to myopia, for in the period of growth the majority of eyes have no need to become short-sighted, seeing that their accommodating-faculty is quite equal to the work to be done, and at the termination of adolescence myopia is more a danger than an advantage If by the term adaptation it is only intended to imply that the alteration is the necessary product of use, its extent and kind, that is quite correct; but it should not be forgotten that this adaptation often oversteps the boundary of health, as in the case of the flat foot of the mountaineer, the pulmonary emphysema of the trumpeter, the arched back of the gymnast, and the short-sightedness of the student; in these cases the function of the organ is overtaxed, and the right medium betwixt rest and work is not preserved.

We may liken the growth of the eye by which it becomes short-sighted to the growth of the muscle we employ in gymnastics. The increase in size of the eye between the ages of 6 and 18 years, occurs during the general growth incident to this period. The effect on the eye is explicable not only by the greater amount of nutrient juices diverted to it in consequence of its increased employment, but also by the very important fact that at this period of life the skull grows more in its longitudinal than in its transverse diameter.* But the growth of the eye as regards its length is intimately connected with that of the skull, as we see in cases where the one eye is hypermetropic and the

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**V. Vierordt* in *Gerhardt's Handbuch der Kinderkrankheiten*, I., 1, 275.

other myopic; in the former the forehead is broad and flat, in the latter narrow and pointed. The increase in size of the eye in such cases is in accordance with general laws; thus it goes on more rapidly when the tissues are soft and yielding, the subject, delicate, weakly, poor in blood, and particularly when there is a hereditary predisposition. As long as this growth of the eye does not go further than to cause the weakest degrees of short sightedness (No. 20 of concave spectacles reckoned in inches, or two meter lenses) it is only of importance from being apt to transmit a predisposition, and on that account it cannot be considered a matter of indifference, far less a desirable quality. But if it goes further and causes a higher degree of myopia, it oversteps the limit of health, becomes a disease, and this disease may be transmitted to offspring. In order to make this more comprehensible we may give an illustration, though it may perhaps be thought to be of too medical a character. The heart is a muscle filled with blood, which can only be kept up to its proper strength by a due exercise of its function. It becomes weak by insufficient nourishment, by poverty of blood, by a too sedentary mode of life; if, for example, a pale over-grown youth, or a chlorotic girl, soon after some serious malady, on leaving school is set to do some severe disproportionate work, such as climbing hills, gymnastic exercise, &c.; there may be produced a life-long dilatation of the heart, so to speak a myopia of the heart, just as myopia of the eye is often rapidly developed during convalescence from measles, scarlatina, or other similar malady; we should beware of over-taxing the eye in the sick room. This little diversion from our theme may be forgiven by our readers if it serves to make their comprehension of short-sightedness clearer and to divest it of its somewhat mystical character.

Before entering on the subject of prevention we may briefly state how it is that short-sightedness may be a source of danger. First, then, in its higher degree it is a great hindrance to the choice of a profession, to getting on in life, to gaining a livelihood. In quite a large number of occupations, particularly those of females, the wearing of spectacles is inadmissible, or such strong spectacles are required that they cannot be endured. He who has experienced the disappointment of having to abandon a calling on account of a high degree of myopia, or of being unable to adopt a wished-for profession for the same reason, has a right to emphasise this social aspect of the subject, especially in a country where the struggle for existence is rendered much more difficult by such a physical weakness.

It would be digressing too much to describe the influence of a high degree of short-sightedness on people of various conditions, habits and qualities. It is a mistake to suppose that spectacles afford a perfect compensation. Apart from the circumstances that they are sometimes dispensed with, that sometimes the strength necessary to correct the myopia cannot be borne, they alter the size, the position and the perspective of what is looked at, all the more the stronger they are. Short-sightedness may be the cause of extreme forwardness or of awkward bashfulness, according as its victim is disposed to be rash or cautious. It is often to blame for the amazing arrangements in form and colour we often see in ladies' dresses and bonnets, and for the awful sins against the laws of perspective we notice in the works of some artists. But we must quit this subject, which has often been treated by physiognomists and psychologists, and return to the question of the real danger attending the higher degrees of short-sightedness.

The degree of myopia which forms the boundary line beyond which danger is the rule, is expressed by a com-

pensating concave lens of six inches focus. As this degree may be easily attained by those who in their twelfth year are only half so short-sighted, a great degree of myopia is dangerous in the inverse ratio of the victim's age. And here is a fact that cannot be too much insisted on:—*The risk to the very short-sighted eye increases with age*, and as a rule becomes always greater from the fiftieth year onwards. How completely this is at variance with the common idea that short-sighted eyes are *good* eyes. And yet this belief is almost universal, the *vox populi!* It was the ophthalmoscope which first taught us that a large number of cases of blindness are connected with the anatomical consequences of an increase in size of the eye.*

A careful consideration of what we have adduced will convince every one that the war against short-sightedness and its spread is completely justified; for those who are becoming short-sighted, for those who are so already, and for those who may hereafter become so. Happily it is being waged all along the line. We must take care that the zeal of the warriors does not slacken! It is not nearly time to cease our beneficent warfare, as far at least as schools are concerned, against which it is necessary our attacks should be directed, seeing that they occupy the whole of the time the danger lasts, and take the child away from his home and family. The school buildings, the desks and seats, the type in which the school books are printed, the black boards, the ink and the pens may be all of the best; it is the discipline which

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* Out of 1848 myopes whom the author examined from 1880 to 1883, 34 per cent. showed serious complications; of these 9.25 per cent. were dimness of the vitreous body, 10.93 per cent. choroiditis, 3.62 per cent. detachment of the retina, and 22.83 per cent. cataract. The average age of these 629 cases of myopia with serious complications is 50.34 years.

insists on good position, which alternates work for the eyes with work for the head and rational gymnastics, that alone can give vitality to these inanimate instruments.

It is certainly as tiresome as it is annoying to be perpetually shouting: "Sit up straight!" The school boy generally remains with his elbows spread out over his desk, raises his head a little by a backward movement of his neck, looks at his teacher for a moment with wrinkled brow, and immediately lets his head drop again over his work. The only way to correct this is to give the word of command: "The arms close to the body!" but for the short-sighted we require something more, we can hardly get on without some contrivance to compel a proper position.

This attention to each individual school-child can only be carried out when the objects of our school development are not palatial buildings and "quiet occupation" (this best method of making bad positions), but the establishment of *small* classes with *few* lessons, and not an exclusive employment of the *eye* as the portal of knowledge. What difficulties we encounter are well known to the author, and it is not in the school alone that we find them. In the child's home more errors are committed and more risks are run. Need we mention reading in the dusk, the mania for music which is so often practised in insufficient light, bad positions when sewing; or need we protest against the almost blasphemous idea of making the *kindergarten* obligatory? These subjects are inexhaustible, but we have not yet spoken of *spectacles* for the short-sighted. It is more difficult to select concave glasses for the short-sighted, than convex glasses for the old-sighted or hypermetropic. For the latter, provided the visual power is intact, spectacles can be prescribed according to simple rules. But even under the similar condition of good normal visual acuity

of the short-sighted, *i.e.*, that he can see normally with the correcting concave glass, the choice of the glass is difficult in the case of young persons and in increasing myopia for many reasons. We must indicate these more precisely. In young persons who during their school career require concave spectacles, in about 35 per cent. too strong spectacles will probably be chosen, if those spectacles are ordered with which, *e.g.*, a boy of fourteen says he sees distant objects best, for they are adapted not only to the length of the eye, but to the constant tension of the accommodation in addition. Therefore the objective myopia should always be ascertained by means of the ophthalmoscope, and the *very weakest* spectacles that enable him to see distant objects selected.

The spectacles needful for distance, as also for the black-board, maps, &c., are only innocuous for near work (writing, &c.) when the wearer adopts the position that a normal-sighted person ought to assume. If he bends down his head as before, the spectacles do him harm ; his short-sightedness then increases more rapidly, and he has to increase the strength of his spectacles quickly. It is difficult to obtain a statistical proof of this in spite of the frequency of individual experience. He who, using the spectacles for distance, brings his fine work as close to his eyes as before wearing spectacles—and this is what is usually done by boys and girls — puts on the full power of his accommodation screw, and thereby sets in action the mechanism which is chiefly instrumental in the production and increase of myopia. Hence concave spectacles, even when rightly selected for distant vision, may prove a danger instead of an improvement ; therefore school-children ought not to be so often required to wear spectacles, if, for instance, they are able to see the figures on the black-board, when these are made somewhat larger than usual.

In high degrees of short-sightedness the spectacles for distance, when used for near vision, do harm, inasmuch as they diminish the apparent size of objects, and thereby cause a greater strain on the eyes. Happily, persons so affected are sometimes wiser than oculists and opticians, and protest that they cannot stand strong spectacles, but very often we find that the injury is already irremediable.

In very high degrees of myopia, however, as a glance at the shape of the short-sighted eye tells us, the range of vision of the central point of the eye is different from that of the periphery, because, owing to the oval shape of the eye, the distance from the anterior surface of the cornea to the central point of the retina is very different from that of the same surface to the equator of the retina. Hence strong glasses are apt to cause confused sight.

The multifarious occupations of every day life—as for example, reading, piano-playing, painting, weaving, school attendance—require one's work to be held at such different distances from the eye, that a special selection of glasses for special distances is necessary, at least for very short-sighted persons.

A great number of other circumstances might be mentioned, which render the selection of concave spectacles a very difficult task, but the hints we have given suffice to show that spectacles, like medicines, may sometimes prove to be poisons. Anyway the following maxims may be attended to with advantage: Concave spectacles are hurtful when they are too strong; when the wearer cannot work with them at the greatest possible distance from his work; when they are not suitable for the working distance, especially in high degrees of myopia. It can easily be understood that it is very important to determine the presence of short-sightedness in school children. For not only can we insist on attention being given to the

regulation of the light, the quality of the work, &c., for these children, but the other children will be benefited because we can with a good conscience require that they too should be similarly cared for. I do not consider it necessary to have special schools for the short-sighted; it is far better to treat all school children as though they might one day become short-sighted.

When on the subject of the different kinds of eyes, we mentioned one kind where neither convex nor concave glasses ground with spherical surfaces were of use, and yet nothing morbid could be seen in the eye. The case was one of irregular curvature of the cornea of the eye. Perhaps the person so affected would tell us that when he looked at the clock on the wall he could see the XII. and VI. on its face, but was unable at the same distance to make out the IX. and III. This imperfection is called *astigmatism*, and it can be corrected by *cylindrical* glasses which have a different refraction in one diameter to what they have in the diameter at right angles with the former. This condition, which is far from uncommon, was only generally known, and its correction by spectacles discovered, about the year 1860. The merit of this also belongs to Donders. A few carefully observed cases, chiefly among learned physicists, were known at the beginning of this century. One of these precursors is especially interesting to us. At Menzberg in Entlebuch their lived, about forty years ago, a clergyman named Schnyder, who noticed that he could not see horizontal and perpendicular lines at the same distance. Whilst holding a thin slit before his eyes he tried to find those glasses which gave him distinct vision at the same distance in several directions, and he thus contrived to construct for himself a pair of spectacles which corrected the faults of his sight. He was the first to determine his astigmatism and to describe a method for doing so that is still employed.

He himself gave an account of it at the meeting of the Swiss Physical Society in Solothurn on the 28th July, 1848. It has been found impossible to obtain the spectacles he used. But it deserves to be recorded that this village clergyman, in his urgent need to see in a normal manner, became an inventor, described his excellent method, and found the man who actually constructed the spectacles in the celebrated optician, Ellenreich Bamberger of Zurich, who must have been well known to some of my older readers.

I have now come to the end of my theme. I might write more on the subject of *smoke-coloured glasses*, which are too often worn, but which should only be employed to ward off *abnormal* lights, or for the protection of diseased eyes; of *cobalt-blue glasses*, which are suitable for assimilating the yellow light from gas and petroleum to the white light of day; of *prismatic spectacles*, which are of excellent service in weakness of the muscles of the eye. But to discuss all these matters thoroughly would be impossible in the scanty space at my command, and within the limits of this popular treatise, which have already been too often over-stepped. If these pages should have the effect of preserving some eyes and of averting the misfortune of blindness so often caused by work, they will have fulfilled the object for which they were written.